

WNMA Project

Real-time crowd information using Bluetooth: a
full-stack solution

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Project Idea: is it possible to exploit Bluetooth to count how many people are there in a room / building and the occupancy trends?

- Seat availability in libraries (without reservation)
- Workforce management (effective deployment)
- Health-critical monitoring (pandemic)

Assumption: BT is a very diffused technology and nowadays most people have a BT-enabled device (smartphone, smartwatch, etc.) with them. Often it is turned on because of low energy consumption.

The scanner is a device that periodically scans ¹the environment for Bluetooth devices and sends the data to the server.
Implemented in Go, can run both on Raspberry Pi and Arduino².

Features

- Low energy consumption
- Low cost hardware
- Easy deployment

Thanks to linux's crontab, the scanner can be scheduled to run at specific times, e.g. every 5 minutes.

¹Use the go-bluetooth library and the BlueZ DBus API

²Can be compiled for Arduino using TinyGo

The server includes both a backend and a frontend developed in a product-ready fashion.

Backend

- Implemented in Go
- RESTful API
- Data storage: SQLite

Frontend

- Implemented in React
- Real-time data visualization

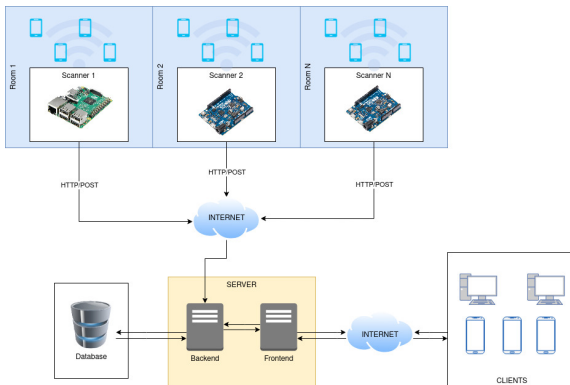


Figure: System architecture

The system has been tested in a real environment: a small local library.

- The scanner (Raspberry Pi) has been placed in a central position
- To avoid hosting costs, the server has been deployed on the Raspberry loopback interface
- Three days of data collection with few people in the library

Field test



```

[WM][0001] New device discovered: addr=60.7F.57.01.77.A0 rssi=-100 alias=60.7F.57.01.77.A0 name=
[WM][0001] New device discovered: addr=43.81.05.35.3B.02 rssi=-99 alias=43.81.05.35.3B.02 name=
[WM][0001] New device discovered: addr=5C.3C.A4.22.95.10 rssi=-93 alias=5C.3C.A4.22.95.10 name=
[WM][0001] New device discovered: addr=69.A5.A7.04.F8.1E rssi=-92 alias=69.A5.A7.04.F8.1E name=
[WM][0002] New device discovered: addr=83.23.2E.F8.6A.3E rssi=-82 alias=83.23.2E.F8.6A.3E name=
[WM][0002] New device discovered: addr=47.C8.15.8C.6A.F3 rssi=-77 alias=47.C8.15.8C.6A.F3 name=
[WM][0002] New device discovered: addr=40.F0.08.00.20.C3 rssi=-94 alias=40.F0.08.00.20.C3 name=
[WM][0002] New device discovered: addr=54.84.3E.05.F7.08 rssi=-97 alias=54.84.3E.05.F7.08 name=
[WM][0002] New device discovered: addr=64.65.09.F8.13.86 rssi=-98 alias=64.65.09.F8.13.86 name=
[WM][0002] New device discovered: addr=78.40.A3.E3.06.17 rssi=-98 alias=78.40.A3.E3.06.17 name=
[WM][0002] New device discovered: addr=59.06.7F.02.29.8E rssi=-102 alias=59.06.7F.02.29.8E name=
[WM][0002] New device discovered: addr=77.ED.8A.A9.75.55 rssi=-93 alias=77.ED.8A.A9.75.55 name=
[WM][0002] New device discovered: addr=AA.12.99.3E.00.48 rssi=-94 alias=AA.12.99.3E.00.48 name=
[WM][0002] New device discovered: addr=7C.3E.3E.87.06 rssi=-98 alias=AGUS-17 name=AGUS-17
[WM][0002] New device discovered: addr=68.57.10.04.76.77 rssi=-94 alias=DESKTOP-WFROJET name=DESKTOP-WFROJET
[WM][0002] New device discovered: addr=58.70.00.52.5B.30 rssi=-94 alias=58.70.00.52.5B.30 name=
[WM][0002] New device discovered: addr=43.60.42.00.04.09 rssi=-81 alias=43.60.42.00.04.09 name=
[WM][0003] New device discovered: addr=AA.31.80.20.50.83 rssi=-93 alias=AA.31.80.20.50.83 name=
[WM][0003] New device discovered: addr=5A.8F.20.44.21.88 rssi=-89 alias=5A.8F.20.44.21.88 name=
[WM][0003] New device discovered: addr=43.6A.40.F2.00.01 rssi=-96 alias=83.6A.40.F2.00.01 name=
[WM][0003] New device discovered: addr=90.7C.20.FB.09.85 rssi=-95 alias=80.7C.20.FB.09.85 name=
[WM][0003] New device discovered: addr=76.2D.6A.C6.3C.78 rssi=-83 alias=76.2D.6A.C6.3C.78 name=
[WM][0003] New device discovered: addr=59.03.01.44.00.30 rssi=-97 alias=59.03.01.44.00.30 name=
[WM][0003] New device discovered: addr=54.8E.10.07.C2.CE rssi=-92 alias=54.8E.10.07.C2.CE name=
[WM][0004] New device discovered: addr=48.02.6C.4F.04.08 rssi=-97 alias=02.6C.4F.04.08 name=
[WM][0004] New device discovered: addr=7C.91.0E.CC.CC.10 rssi=-100 alias=7C.91.0E.CC.CC.10 name=
[WM][0004] New device discovered: addr=60.A0.03.00.00.37.C5 rssi=-78 alias=ARG030853* name=ARG030853*
[WM][0004] New device discovered: addr=78.45.1A.8E.0F.22 rssi=-98 alias=78.45.1A.8E.0F.22 name=
[WM][0004] New device discovered: addr=58.3E.30.C3.C7.F1 rssi=-94 alias=58.3E.30.C3.C7.F1 name=
[WM][0004] New device discovered: addr=40.83.40.EE.C5.AA rssi=-85 alias=40.83.40.EE.C5.AA name=
[WM][0004] New device discovered: addr=55.05.A5.15.59.06 rssi=-101 alias=55.05.A5.15.59.06 name=
[WM][0005] New device discovered: addr=4C.9C.95.66.90.50 rssi=-99 alias=4C.9C.95.66.90.50 name=
[WM][0005] New device discovered: addr=61.FA.8A.C3.14.61 rssi=-97 alias=61.FA.8A.C3.14.61 name=
[WM][0005] New device discovered: addr=65.41.59.70.31.C5 rssi=-92 alias=65.41.59.70.31.C5 name=
[WM][0006] New device discovered: addr=50.16.84.4E.0A.23 rssi=-86 alias=50.16.84.4E.0A.23 name=
[WM][0006] New device discovered: addr=80.52.16.AC.20.32 rssi=-89 alias=LPTOP-1E7595A name=LPTOP-1E7595A
[WM][0007] New device discovered: addr=4F.09.09.50.69.44 rssi=-95 alias=4F.09.09.50.69.44 name=
[WM][0007] New device discovered: addr=63.0E.0E.7A rssi=-97 alias=63.0E.0E.7A name=
[WM][0007] New device discovered: addr=70.A0.30.53.1E.20 rssi=-87 alias=70.A0.30.53.1E.20 name=
[WM][0007] New device discovered: addr=65.FF.92.85.3A.3A rssi=-80 alias=65.FF.92.85.3A.3A name=
[WM][0008] New device discovered: addr=60.C4.78.E2.33.75 rssi=-95 alias=C4.78.E2.33.75 name=
[WM][0008] New device discovered: addr=40.8C.6F.CE.24.3F rssi=-94 alias=40.8C.6F.CE.24.3F name=
[WM][0008] New device discovered: addr=5E.7F.00.F8.C4.8C rssi=-99 alias=5E.7F.00.F8.C4.8C name=
[WM][0009] New device discovered: addr=7A.5F.55.2A.83.78 rssi=-80 alias=7A.5F.55.2A.83.78 name=
[WM][0009] New device discovered: addr=78.86.8C.43.2E.AA rssi=-92 alias=78.86.8C.43.2E.AA name=
[WM][0009] New device discovered: addr=47.51.08.06.C6.07 rssi=-95 alias=47.51.08.06.C6.07 name=
[WM][0009] New device discovered: addr=22.14.70.E1.43.35 rssi=-100 alias=22.14.70.E1.43.35 name=
[WM][0010] New device discovered: addr=00.06.E0.40.84.0F rssi=-97 alias=00.06.E0.40.84.0F name=
[WM][0010] New device discovered: addr=48.10.1A.37.09 rssi=-94 alias=48.10.1A.37.09 name=
[WM][0010] New device discovered: addr=74.07.03.04.73.40 rssi=-93 alias=74.07.03.04.73.40 name=
    
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